Roadway Data Collection in the Transportation Data Office of the Washington State Department of Transportation

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Washington State
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Table of Contents

Introduction

This is a brief history of roadway data collection in the Roadway Systems Branch of the Washington State Transportation Department's Transportation Data Office. It was put together at the request of Larry Severtson, the Branch Manager.

This document could not have been written without the assistance of the following members of the roadway systems branch:

Lee Arnold--Video Logging
Lou Baker--Geometrics
Mike Bernard--ROAD Project
Rod Bleecker--Video Logging
Glenn Davis--ROAD Project, Mainline Project
Mark Finch--Roadway Data Supervisor
Eric Jackson--SR View
Brian Limotti--Documentation
Tom Lubenau--Databases
Max Shade--ROAD Project, Mainline Project
Paul Sullivan--Databases

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Data Collection from 1940's to the Present

The Roadway Systems Branch of the Transportation Data Office (TDO) has evolved over forty years from an organization that used paper and pencil to collect data about features on Washington State highways to one that uses the latest technology to collect data. This paper is intended to describe that evolution and outline new directions the Roadway Data Section will take as it masters the newest technology.

The State Highway Log

The *State Highway Log*, frequently referred to as the "Road Log", is produced by the Roadway Systems branch and provides the most current data about features and geometrics on State highways. It also provides a record of distances between features along highways. Various Department of Transportation Directives assigned responsibility for gathering, maintaining, and setting standards for Roadway Data to the Roadway Systems Branch of the TDO.[1]

Originally, two crews using pencil and paper "Code Sheets" collected data for the Log. In 1984 this was increased to four crews. Distances along highways were measured using tape measures and measuring wheels. Eventually, Distance Measuring Instruments were introduced that allowed crews to measure distances on the highway faster and with greater accuracy.

Once data was collected it was typed, reproduced, printed and distributed to a wide variety of customers both within and outside the Department of Transportation. The Log was the standard reference used in DOT for feature information and Roadway and Intersection information and the State Route Milepost system. This information was and is used by planners and maintenance crews in DOT, other State agencies such as the Washington State Patrol, counties and cities, and private organizations, particularly utility companies.

In 1986 the Transportation Information and Planning Support (TRIPS) system was brought online which enabled automation of the Log. Roadway geometrics,

[1] Washington State Department of Transportation (WSDOT), *State Highway Log* (Olympia, WA: WSDOT Planning and Programming Service Center, 2000) Introduction; WSDOT, *State Route Mileposts* (Olympia, WA: WSDOT, April 30, 1979) Directive D 32-20 (PD); WSDOT, *State Route Mileposts* (Olympia, WA: WSDOT, September 28, 1983) Directive D 32-20.

structures, classifications, geographic information, and jurisdictional boundaries were stored in the TRIPS database. In addition to inventories conducted by field crews, the TRIPS database and the Log were updated with information received from DOT's regional offices and contractors' plans.[2] In 2000, Walt Knowlen produced the first electronic versions of the Log. It is now available in paper, email, web, and CD versions.

Even though technological improvements were made in storing roadway data, the collection of that data was fraught with problems. While standards for inventories and collection were set by the Department,[3] the crews generally developed their own methods and standards which were often inconsistent. One important source of errors was in the use of Distance Measuring Instruments (DMI). Each crew used different calibration methods which made verification from one crew to the next or one year to the next difficult, if not impossible. The DMIs were not very sophisticated, were inaccurate and inconsistent from one counter to the next. The errors introduced were by this equipment were mild at the beginning of the route, but became extreme as the route progressed, especially on the longer routes.

Receipt of contract plans and Region Office updates also created problems in maintaining accurate information in the Log's database. While contractors were required to provide contract plans and Region offices were required to report highway modifications to the Roadway Systems Branch, the information frequently was not received or updated until the Roadway crews made their field inventories. As a result, changes in traffic channelization, modifications to the roadway, or illumination and signage changes made by Department maintenance personnel, construction by utility companies and curbs, gutters, and sidewalks built by developers were not kept up to date. Personnel cuts also created difficulty in keeping up with requirements and made it impossible to keep up with annual inventories. Currently, while annual inventories are required, only spot checks are done. [4]

Video Log

Prior to 1982, the Roadway Systems Branch and its predecessors maintained a Photo Log library. The library provided customers with "coordinated 35 mm pictures of the state routes."[5] These still photos were taken from a Photo Van every .01 mile and sent to a company in New York to be put on 35 mm filmstrips. Customers could come to the library and view the filmstrips on microfilm machines or have copies made. The library would make copies of the filmstrips for the Attorney General, Department planners, or the general public. The photos and filmstrips were updated every two years.

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[2] WSDOT, *TRIPS User's Guide* (Olympia, WA: WSDOT, 1994), 2.
[3] WSDOT, *Roadway and Intersection Inventory Manual* (Olympia, WA: WSDOT, April, 1988).
[4] WSDOT, *Certification of Routes through Cities and Towns* (Olympia, WA: WSDOT, August, 1985) Directive 33-10.
[5] WSDOT, *Data Development and Analysis in the Public Transportation and Planning Division* (Olympia, WA: WSDOT, 1982), 3.

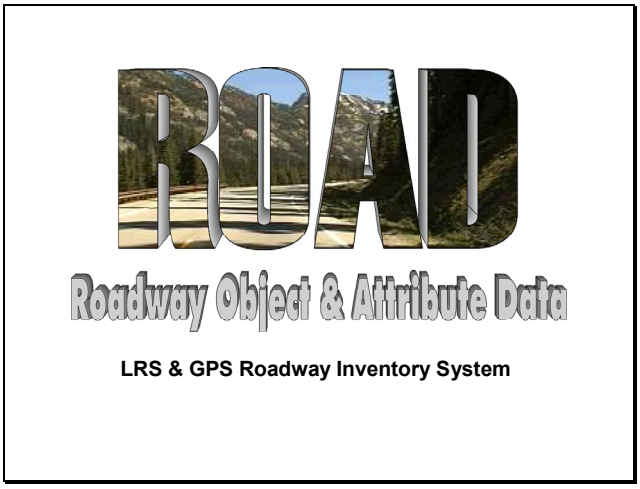
Shortly after 1982, Photo Logging was replaced by Video Logging. VideoLogging uses videotape footage instead of photographs. Videotapes are made available to customers just as the filmstrips were. Like the Photo Log, the Video Log is also updated every two years.

SR View

In 1996, Eric Jackson, an employee of DOT headed up a team that developed SR View. This program allowed customers within DOT to view digital images of the videos online. By the end of 1997, state routes in 3 regions were available on the system and by April 1998, the entire highway system was available. That same year a Web version was available to the general public. Additional improvements will include 360° views of intersections and a stop motion DVD edition.

GPS

The TDO first tested Global Positioning System collection equipment in July 1996 when a GPS receiver was installed in the video van to see if the video log could be tied to GPS. While this experiment was not successful, the TDO gained great insights to the use of GPS.



Road Project

In 1996, the Roadway Object and Attribute Data (ROAD) project began, originally funded by the FHWA through the University of North Carolina's Highway Research Center. ROAD was originally a pilot program to see if the collection of roadside features affecting traffic safety was feasible.

A contractor, Jeff Scott, created the ROAD Features database for this project in fall of 1997. The database was used to store GPS data collected for the project. Currently this database is archived and unused.

The ROAD Crew, Mike Bernard, Glenn Davis, and Max Shade, began collecting features along SR 3 as a test of the system and the ROAD Features database. The crew used a van configured with a Trimble Pro XR® GPS receiver. Data collected was verified and indexed to the state's Linear Referencing System by using the MADDog extension of ArcView®. MADDog, created by WSDOT Geoservices used old US Geologic Service quadrangle maps to create the base highway system. The ROAD Crew discovered that these maps were not accurate. To collect data accurately, the crew needed to establish a GPS baseline for each highway.

As the crew set out to collect the mainline center line location for the baseline, they soon discovered that the GPS signal would frequently get lost under tree cover and varied terrain. A contractor, Bob Lewis, was called in. Mr. Lewis had previously set up an inertial navigation system for the State of Tennessee for a similar purpose. The Road Van was soon outfitted with an inertial navigation system consisting of a gyroscope and barometric altimeter to fill in gaps created when GPS signals could not be received. Once this problem was worked out, collection continued and features were tied to the new GPS centerline. The project ended in July 1999 when funding ended.

Databases and Reports

The Roadway Systems Branch has created and is responsible for a number of databases and database applications used in collection, storage, and analysis of roadside data. This section describes a few of the databases developed by the branch.

ROAD Features Database

The ROAD Features Database is a Power Builder® application used to collect mainline and feature data from GPS. This application required four personnel to collect data. Two people on the ground were required to acquire GPS positions for the features using the Trimble Pro XR® equipment. The ground personnel relayed the point, GPS location, and attributes of the feature to the Crew Chief located in the Road Van. The Crew Chief entered the information into the Database on a PC in the Van (Fig. 1). A fourth person was used as a driver/traffic control. See Appendix I for sample data entry screens for the database.

State Highway Log

The State Highway Log, also known as the "Road Log" is one of several reports produced by the Roadway Systems Branch from the TRIPS database. The Log contains

roadway data and mileage statistics for all state highways. It provides a reference of the most current highway system information and is the approved source for determining distances on the highway system.[6]

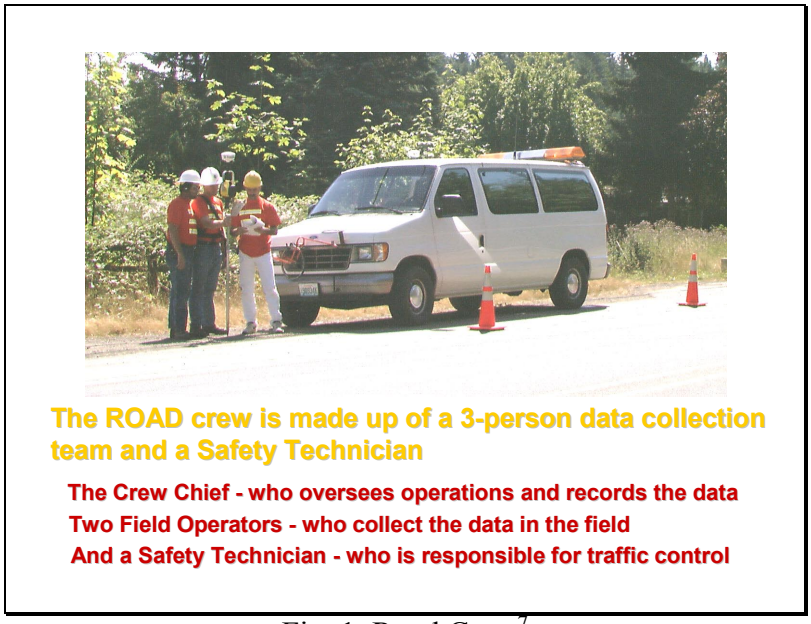


Fig. 1 Road Crew[7]

Maintenance Database

The Maintenance Database is a prototype Power Builder® application created in partnership with WSDOT's North Central Region. The partnership was intended to minimize duplication of effort in collecting roadside features, provide access to historical data, and facilitate planning, scheduling, and reporting. This partnership also required the standardization of naming conventions for roadside features.

The database, intended to be user friendly, combined the ROAD Features Database and a Maintenance Inventory Database. The ROAD system, as previously described used the Linear Referencing System and GPS to locate features and their attributes. The University of North Carolina identified features for collection as part of the ROAD project. Additional features were identified by WSDOT's Maintenance, Risk Management, Engineering, and Design teams.

Three methods were used to collect data for the database: mobile collection, manual collection, and remote acquisition. The mobile platform (ROAD Van) makes a

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[6] WSDOT, *State Highway Log,* Introduction.
[7] Hartsell, Robin, "A Partnership of Data Utilization," (Olympia: WSDOT North Central Region and Transportation Data Office, 2000).

control run to create a "smart line" by collecting GPS points for the highway centerline. Where GPS signals cannot be acquired, the van is equipped with a Distance Measuring Instrument, gyroscope, and barometric altimeter, which fills in the missing data.

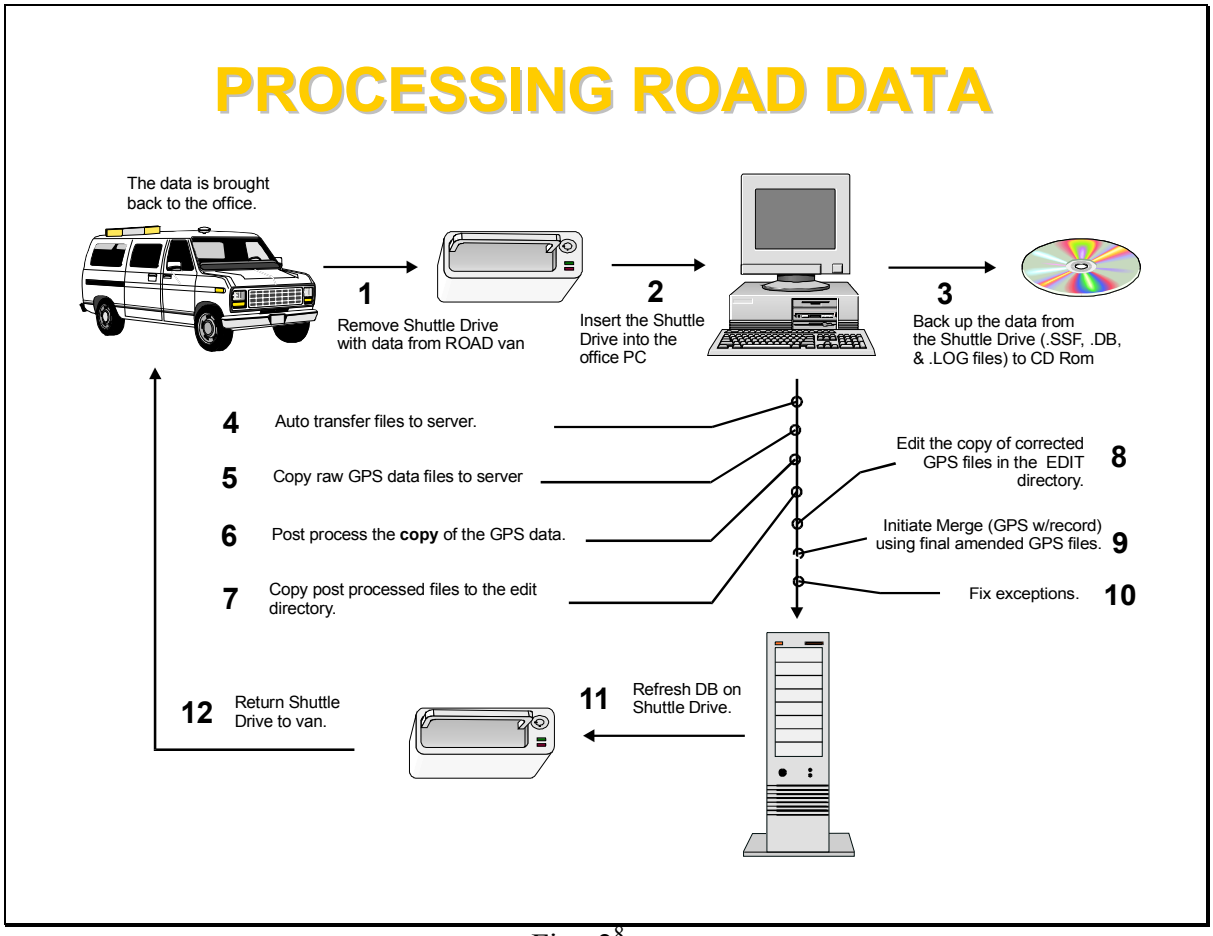

Fig. 2[8]

Roadside features inventory data is collected by a field operator who uses measuring instruments and GPS to collect features. The information is relayed to the Crew Chief, who enters data in the Road Van computer. The computer generates an identification number that links the GPS data to the feature record. Data that cannot be collected manually can be acquired by using an offset device such as a laser rangefinder. Once the data is collected it is taken back to the office and post processed (Fig. 2). After it is post processed it then can be used for accident information, location of maintenance requirements, project and construction design, and risk management.

In May 1999 sample segments of SR 2 and SR 28 were run to help demonstrate the database. While the test was successful, the project was postponed and the database archived. Even though the database is currently not used, it has potential for use as an

[8] Hartsell.

asset management system, which soon will be required by the FHWA and under GASB 31.[9]

Current Data Collection Initiatives

The Roadway Systems Branch continues to collect and update the TRIPS database, update the Video Log and produce the Road Log. However the Branch has taken on two new initiatives based on the Branch's extensive experience in collection methods. These initiatives are the Mainline Project and the GPS Training Program for Mapping Grade Equipment.

Mainline Project

The Mainline Project is an outgrowth of lessons learned during the ROAD Project. In attempting to use the DOT base map, the crew realized that the base map, while accurate enough for producing tourist maps was too inaccurate to use for feature collection. To correct this, the ROAD crew began collecting "smart lines" to tie features to. This new centerline could be used to correct the state's base map.

In March 2000, the TDO and Geoservices partnered to upgrade the base map. The project, funded jointly, uses the equipment and procedures established during the ROAD project and adapted for the Maintenance Database to collect GPS and inertial data. Personnel from both TDO and Geoservices work together in collecting and processing the data for the project. At the time of this writing, the Mainline Road Crew has collected data on over 8,665 lane miles out of 14,123 and 1,269 miles have been processed, ready for use in updated mapping products.[10]

GPS Training Program for Mapping Grade Equipment

In August of 1997, the National Geodetic Survey and WSDOT produced a white paper outlining problems the Department faced in using GPS equipment. Among the problems identified were a lack of consistency in equipment, standards, and procedures. This made it impossible for offices to share data or resources with other offices in the Department. Another problem the white paper identified was the lack of training and support personnel in the Department. As interest grew in GPS technology, there was not enough time, equipment, or personnel available to perform all the tasks required. The

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[9] Governmental Accounting Standards Board, "Basic Financial Statements and Management's Discussion and Analysis for State and Local Governments," GASB Statement Number 34, June, 1999.
[10] Glenn Davis, GPS Section, Roadway Systems Branch, Transportation Data Office, WSDOT, January 31, 2001.

white paper recommended decentralizing GPS equipment and collection, standardizing equipment, procedures and standards, and creating training and support positions.[11]

The Department has acted on several of these recommendations. During the summer of 2000, an equipment evaluation team held a competition to determine which systems should be used in the Department. Leica Geosystems, Inc. was chosen to provide its GS50 for mapping applications. Training was assigned to several sections. Geoservices is responsible for survey grade equipment training, the TDO for mapping grade equipment, WS Ferries for vessel applications, and Aviation division for aircraft applications. The TDO took the initiative and created a GPS trainer position in August 2000.

So far, no organization within the department has been assign responsibility or the lead in setting and enforcing standards.

The GPS trainer is currently developing training in conjunction with Leica Geosystems for Leica's GS50 Mapping Grade GPS system. The training program will be listed in the Department's Automated Training Management System and will be available to personnel in the Department as well as to personnel of other State Agencies, county, city, and other governmental organizations.

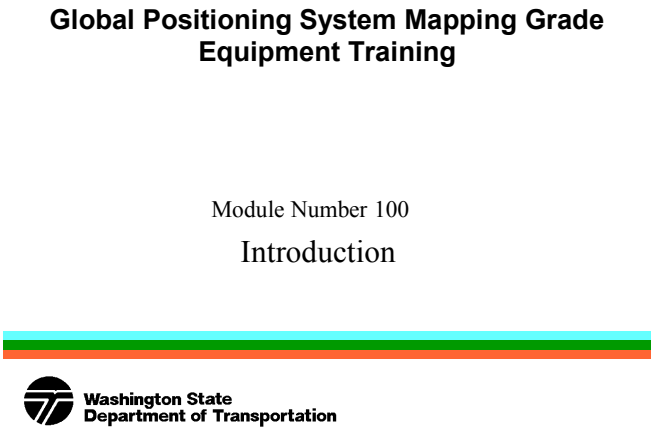

Fig. 3

In addition to the basic GPS for Mapping Grade equipment, a GPS course for managers and an advanced techniques and procedures course will be created. The basic GS 50 course will be ready early to mid February. The GPS trainer will also serve as a consultant for offices who need advice and assistance in setting up projects using mapping grade GPS equipment.

[11] Gary Perasso, Roger Caddell, and Kurt Iverson, "The Future of GPS Technology in WSDOT," WSDOT, August, 1997.

While developing the course, the GPS trainer has completed a study comparing the relative accuracy of using GPS and Distance Measuring Instruments for determining road distance and will conduct a study comparing accuracy and repeatability of handheld GPS receivers with Mapping Grade instruments. The GPS trainer is also tasked with keeping abreast of technological developments in GPS/Geographic Information Systems. He is working closely with Leica Geosystems, Inc. to develop both the DOT's training program and Leica's train the trainer program. He also maintains a membership in the Institute of Navigation, one of the leading international organizations dealing with GPS technology.

References

Davis, Glenn, GPS Section, Roadway Systems Branch, Transportation Data Office, WSDOT, January 31, 2001.

Governmental Accounting Standards Board. "Basic Financial Statements and Management's Discussion and Analysis for State and Local Governments," GASB Statement Number 34. GASB, June, 1999.

Hartsell, Robin. "A Partnership of Data Utilization." Olympia: WSDOT North Central Region and Transportation Data Office, 2000.

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_____. *State Route Mileposts.* Olympia, WA: WSDOT, September 28, 1983. Directive D 32-20.

_____. *TRIPS User's Guide.* Olympia, WA: WSDOT, 1994.

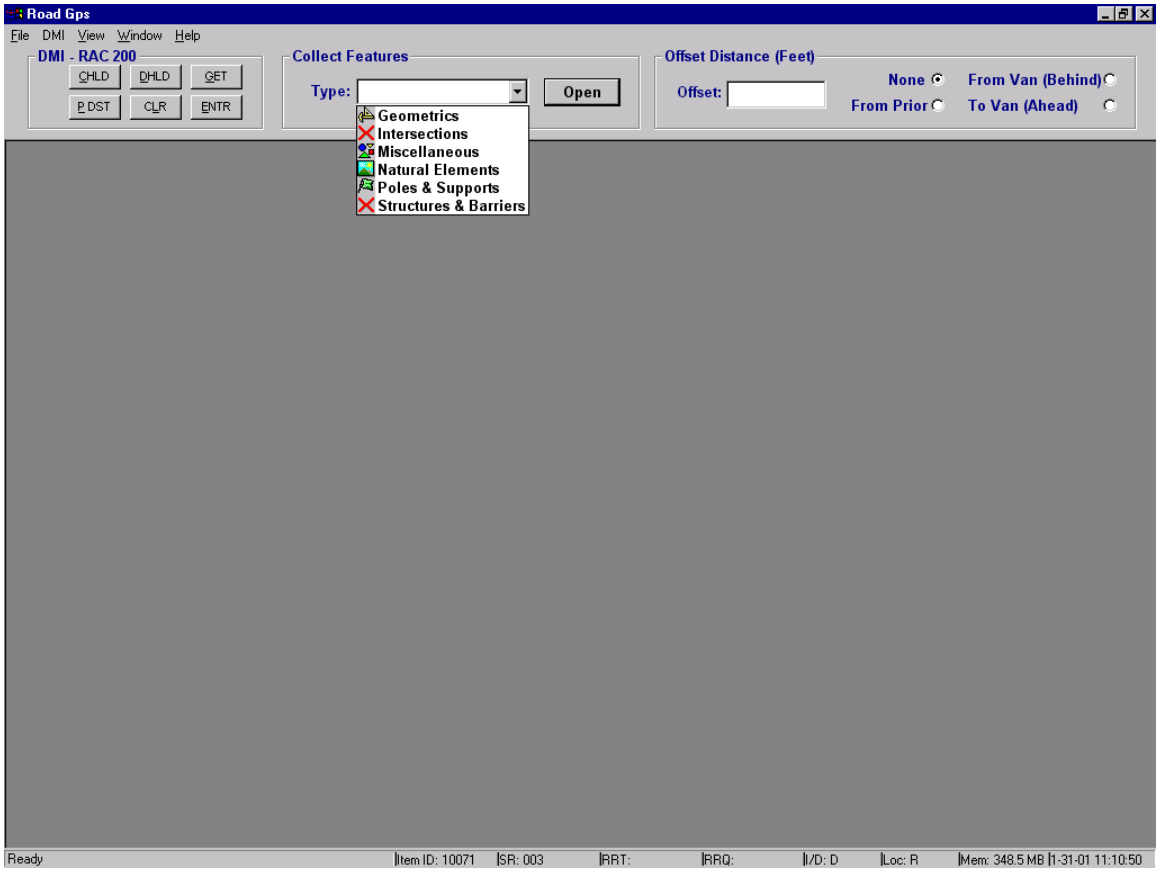
_____. *Roadway and Intersection Inventory Manual.* Olympia, WA: WSDOT, April, 1988.

_____. *Certification of Routes through Cities and Towns.* Olympia, WA: WSDOT, August, 1985. Directive 33-10.

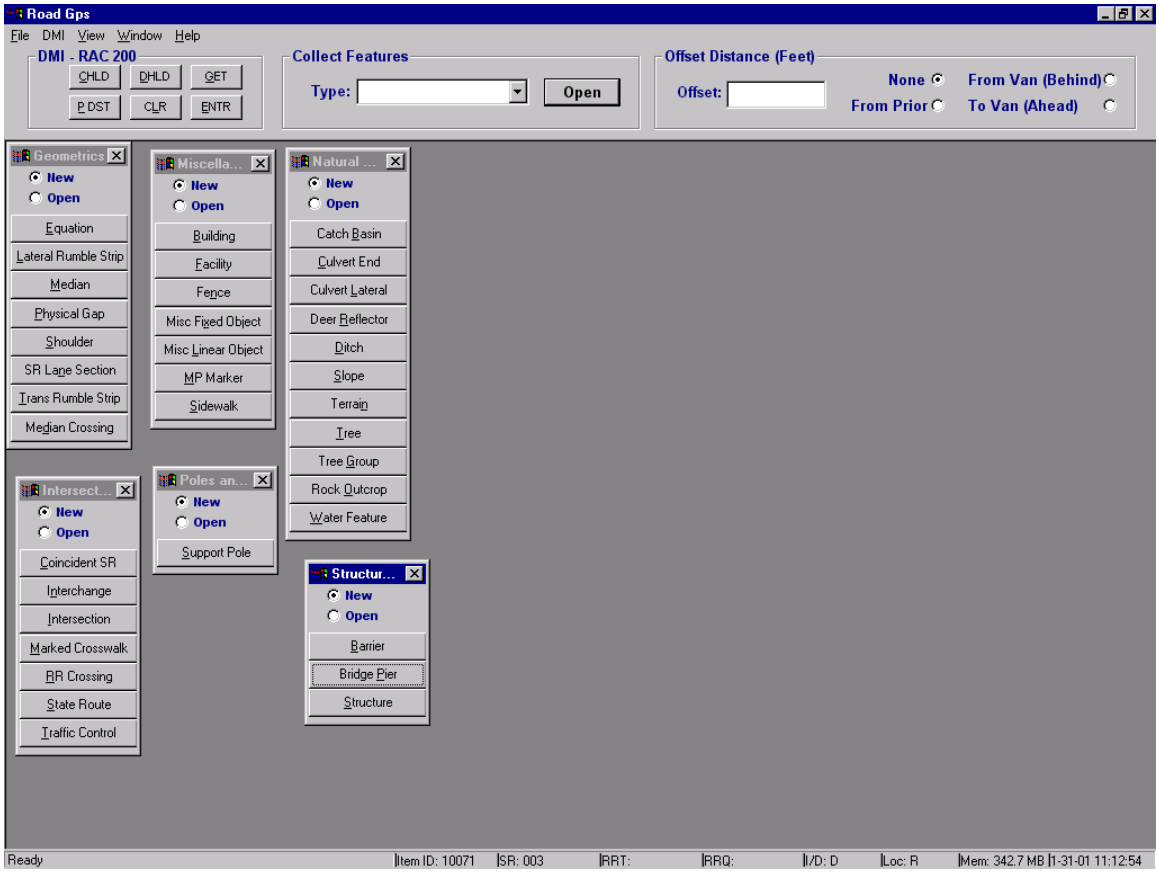
_____. *Data Development and Analysis in the Public Transportation and Planning Division.* Olympia, WA: WSDOT, 1982.

Appendix I

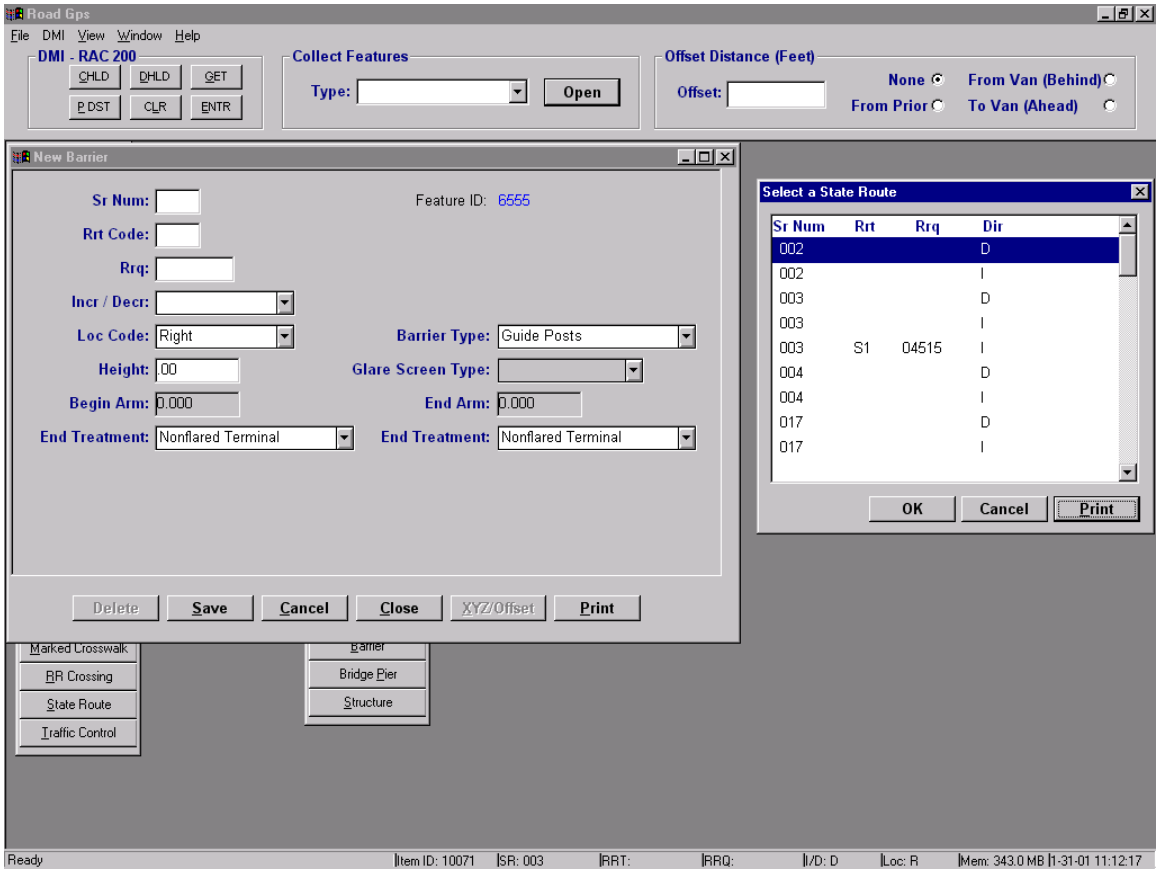
The Road Features Data Base



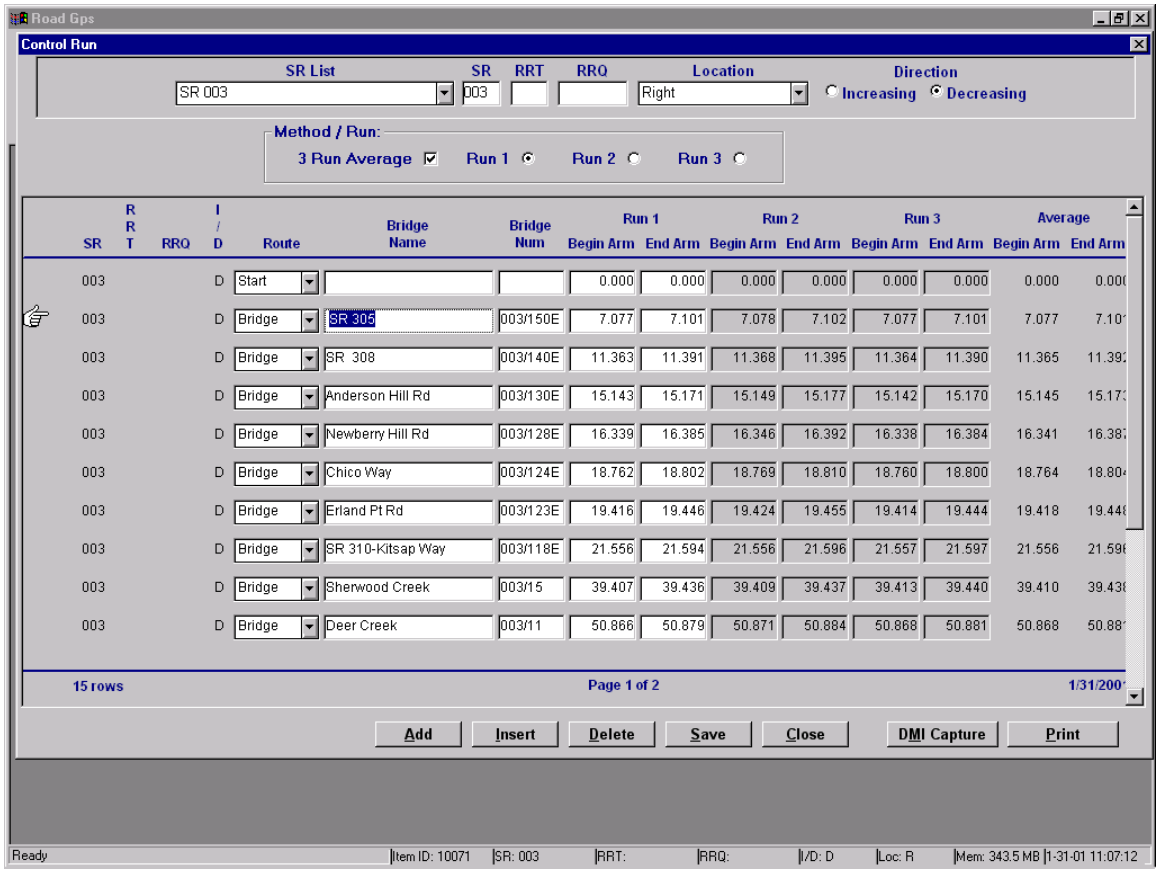
Main screen for Road Features Database program. This screen allows the operator to use a pull down screen to input various features.



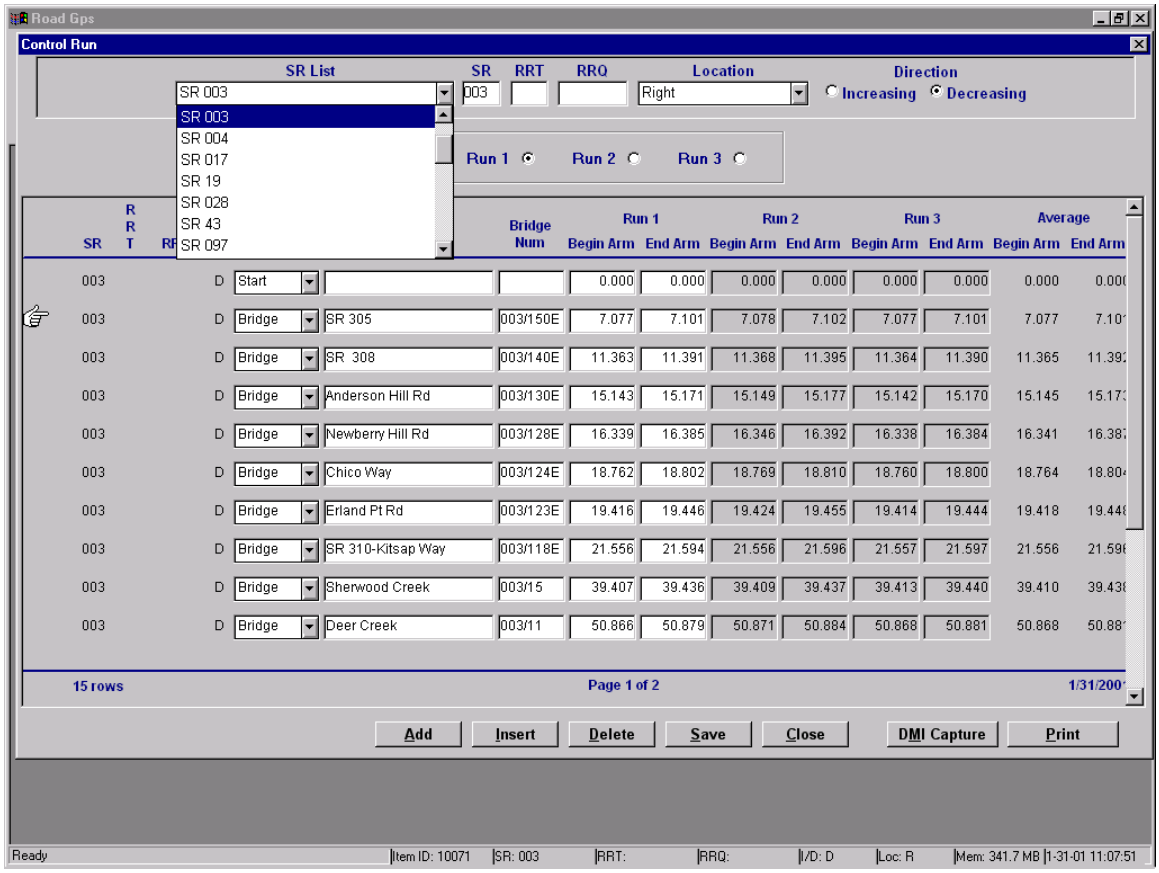
Each feature type has a separate menu which allows operator to assign attributes to specific features.



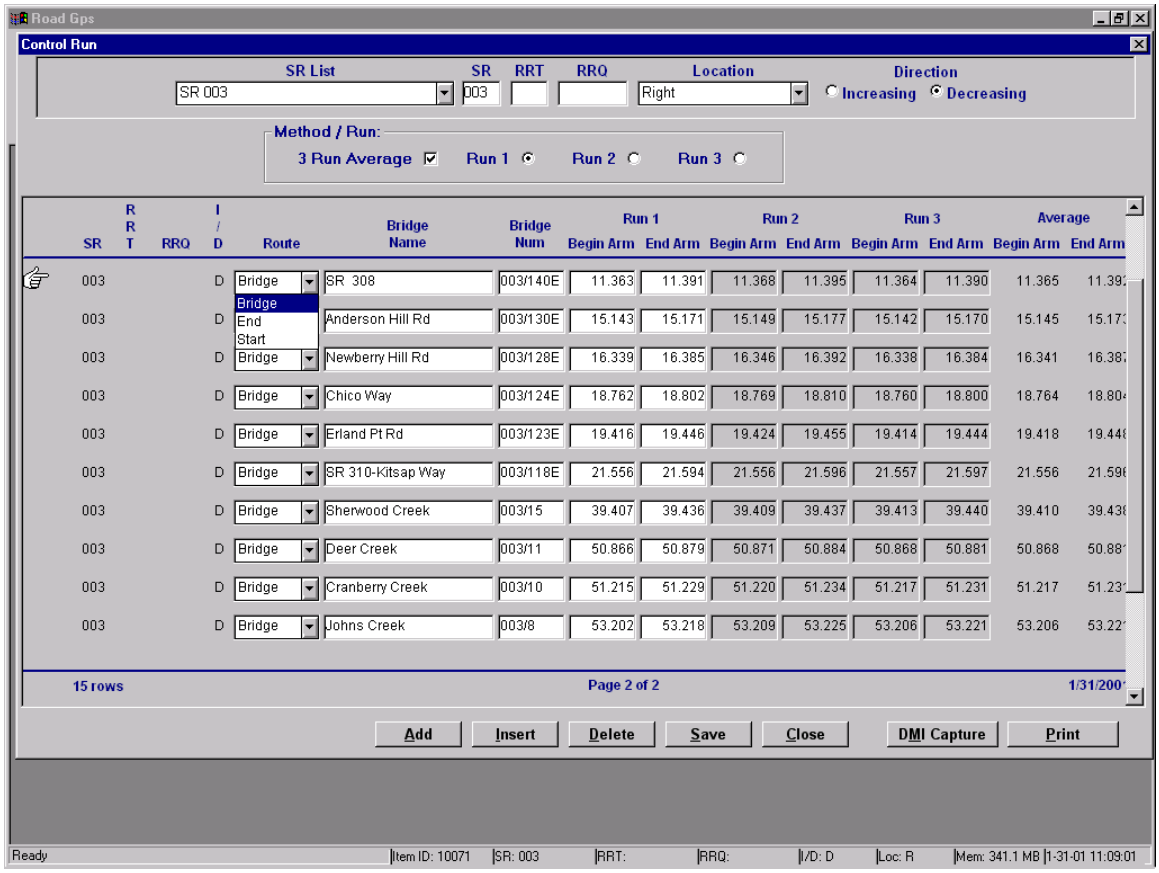
Clicking on a feature type allows data to be entered.



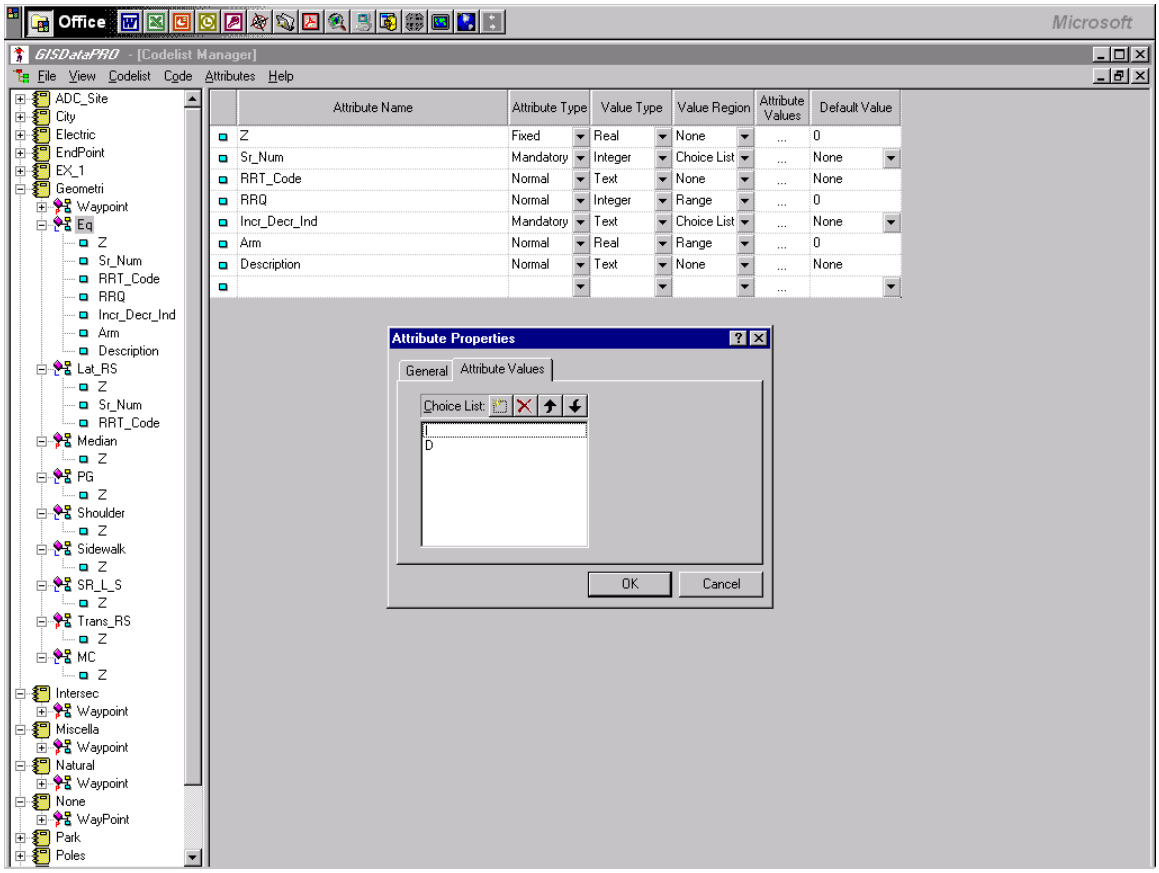
Feature data by State Route.



Pull down menu allows selection of State Route.



Pull down menus allow insertion of features.



GISDataPRO Codelists and attributes.